REMARKS

This paper responds to the Office Action mailed September 25, 2003.

Claims 10 to 21 were previously withdrawn in response to an election requirement. By this amendment, Claim 10 has been amended by being rewritten in dependent form. Claims 11 to 21 remain in their original form.

Page 1/3 of the drawings has been amended to correct some errors in the reference numbers of Figure 2. A new page 1/3 accompanies this response. The corrected references are 34, 30 and 14.

Claims 1 –9 have been rejected under 35 U.S.C. §103(a) as being unpatentable over "Shieh" in view of "Noe". Reconsideration is requested.

The invention of claim 1 is a device which enables a required differential group delay (which can be considered to be first order PMD) to be obtained in a simple manner and without introducing any second order PMD.

The invention of claim 1 achieves this by combining two factors:

The first factor is a series of three birefringent elements, having DGDs in the ratio 1:2:1. DGD is measured in units of time, typically picoseconds, ps, as it represents the time delay between signals travelling along different polarization axes. The longer a fiber, the more DGD will be introduced, and these birefringent elements are typically long lengths of fiber, having a DGD of the order of picoseconds.

The second factor is that polarization rotation takes place between the first and second birefringent elements and between th second and third birefringent elements. These amounts of rotation are equal and opposite. The rotation is

measured as an angle, but is frequently expressed as a fraction of the wavelength. For example, a quarter wave plate gives a rotation of one quarter of the wavelength ($\lambda/4$), which is equal to 90 degrees, or $\pi/2$ radians.

The structure of the invention can be understood most easily from Figure 2. The birefringent elements 10, 12, 14 have DGDs in the ratio 1:2:1. The birefringent elements do not provide any polarization rotation themselves. Polarization rotation is performed by the polarization controllers 30, 32. Alternatively, as in the example of Figure 1, the birefringent elements may be physically rotated to achieve the same effect.

These two features are essential to the invention of claim 1.

The Examiner's rejection is based largely on the argument that the phase delay introduced by a quarter wave plate is equivalent to a differential group delay. A quarter-wave plate consists of a carefully adjusted thickness of a birefringent material such that the light associated with the larger index of refraction is retarded (i.e. delayed) by 90° in phase (a quarter wavelength) with respect to that associated with the smaller index.

The Examiner's argument is that this delay can be considered to be a time delay. For an optical communications system, the optical wavelength is around 1500nm. Thus, a delay of one quarter of a wavelength represents a delay equating to 375nm. At the speed of light, this corresponds to 1.25×10^{-15} s, namely 0.00125ps. This time delay is negligible, and can be ignored. Indeed, this differential time delay is ignored in the calculations on pages 16 and 17 of the instant application, and the effect of a quarter wave plate is simply represented as an instantaneous polarization rotation.

In the example described on page 23, each birefring nt l ment provides up to 2ps of DGD. In Noe, th PMF sections have 10ps of DGD each.

The claims of the instant application are directed to a device for applying a variable differential group delay. This clearly requires elements with non-negligible DGD, and Applicant submits therefore that quarter and half wave plates alone cannot be considered to a provide system for introducing a variable differential group delay.

In order to clarify this distinction, claims 1 and 21 have been amended to specify that the birefringent elements have DGDs which are "significantly larger than the optical period of the signal at the input of the device".

Shieh discloses that the plate elements are "cascaded on a low birefringence optical medium". A medium of low birefringence will by definition have low DGD, as it is the birefringence of a medium which gives rise to DGD. The device of Shieh is clearly not intended **or suitable** for applying a variable differential group delay. There are no components in the device of Shieh having significant DGD, and there is therefore no scope for applying a variable DGD.

The examiner has recognized that Shieh fails to disclose the DGD ratio of 1:2:1. However, **Noe also fails to disclose this DGD ratio**. In the cited passage, it states "... consisting of three PMF sections with 10 ps DGD each". Thus, the DGD ratio of the three PMF sections is 1:1:1. PMF is polarization maintaining fiber, which causes no polarization rotation. The "λ/4, λ/2, λ/4 plates" are quarter wave plates and a half wave plate, and these are devices for polarization rotation. Again, these devices have negligible DGD as demonstrated above. They certainly do not have DGDs which are significantly larger than the optical period of the signal at the input of the device, as required by the amended claims.

Thus, there is no disclosure or suggestion in Shieh or Noe of an arrangement of three birefringent elements having DGDs in the ratio 1:2:1. The combination of this with qual and opposite polarization rotation between the first and second and

between the second and third birefringent elements is not disclosed or suggested by the prior art either alone or in combination.

Claims 21 is also rejected under 35 USC 102(e) as being anticipated by Shieh. Claim 21 is directed to the device shown in Figure 4, and the control scheme explained with reference to the table on page 23 of the instant application. The device has a series of birefringent elements 56 with polarization rotation between adjacent elements.

Again, Applicant maintains that Shieh fails to disclose any birefringent elements, but particularly not having DGDs which are significantly larger than the optical period of the signal at the input of the device. As shown in Figure 4 of the instant application, the birefringent elements 56 are implemented as lengths of fiber. The device of Shieh is not for controlling DGD, but is simply for controlling polarization rotation.

Noe fails to disclose any arrangement of four or more birefringent elements, and also fails to disclose the control scheme required by claim 21.

Accordingly, the Applicant respectfully submits that amended claims 1 and 21 are both novel and not obvious in view of the cited prior art.

The amendments made to the claims merely clarify the intended meaning of the claims in their previous form. For this reason, it is submitted that the amendments do not raise new issues, and should be entered.

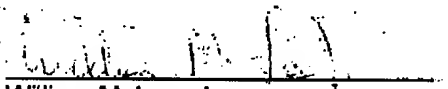
Detailed arguments are not presented in respect of the dependent claims. However, the arguments of the Examiner should not be taken to be accepted.

In view of the arguments above, it is submitted that this application is in order for allowance. Such action is therefore solicited.

This response is being filed within 2 months of the mailing of the final Office Action.

November 25, 2003

Respectfully submitted,



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